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KENTUCKY DEPARTMENT OF HIGHWAYS

RESEARCH REPORT

I-75 KENTON COUNTY SLIDE
KYHPR ⁴⁸⁵ 63-16, HPR-1(4), PART II

By

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⁴⁷⁰
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DIVISION OF RESEARCH

Lexington



September 1968



WILLIAM B. HAZELRIGG
COMMISSIONER

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT, KENTUCKY 40601

December 3, 1968

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H-2-16

MEMO TO: A. O. Neiser, State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report (Interim);
"I 75, Kenton County Slide;" HPR-1(4),
Part II; KYHPR-63-16

The report submitted herewith recapitulates significant circumstances attending the I 75 slide and subsequent restoration of the roadway. Two reports were issued much earlier, they are:

1. "Status Report on Landslide Area on I 75, Covington, Kentucky;" May 15, 1963.
2. "(ditto)," August 1, 1963.

The two earlier reports provided information which was useful in the reconstruction plan. You may recall that reconstruction was programmed in two phases (Nos. 323 and 324): Phase I work was authorized under FI 75-8(21)187 and SP 59-315-30; Phase II has not been initiated.

The parent research study (KYHPR-63-16), as originally conceived, is entitled: Development of a Practical Method of Locating and Tracing Seepage Water in Unstable Slopes. Case studies have been conducted at numerous slide areas in the interim; collectively, these studies have produced mutated rewards extending far beyond the original purview: one is the analysis of the stability of earth embankments and foundations (cf. "Stability Analyses of Earth Masses;" Deen, Scott, and McGraw; September 1966). Another was the staffing of soils engineers in the Division of Materials to assure competence in earthwork structures.

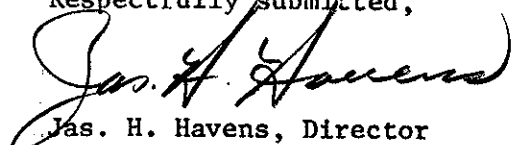
Unfortunately, we have not discovered any "water witching" innovations, but this aspect of the parent study will be confronted more directly in a subsequent and final report--which will not be limited to the I 75 slide. The current report fulfills a specific commitment regarding the I 75 slide area. Offending water conditions still persist there--evident as wet spots on the embankment slopes. Several contributory conditions involving broken sewer lines and submerging surface drainage were reported to Mr. Johns by memorandum, May 1, 1968.

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December 3, 1968

We continue to be somewhat apprehensive about apparent movement at the upper fill. Release of a sizable pocket of water there (November 20, 1967) may have averted failure of the embankment. Subsequent movement, of course, may be due to "creep;" but we are hopeful that it is due to consolidation of the fill material--resulting from release of captive water.

Respectfully submitted,



Jas. H. Havens, Director
Division of Research

JHH:em

Attachment

cc's: Research Committee

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W. B. Drake, Assistant State Highway Engineer
J. T. Anderson, Projects Management Engineer
K. B. Johns, Operations Management Engineer
J. R. Harbison, Program Management Engineer
C. G. Cook, Director, Division of Construction
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Associate Dean, College of Engineering, U. of Ky.

Research Report

I 75, KENTON COUNTY SLIDE
KYHPR 63-16, HPR-1(4), Part II

by

Herbert F. Southgate
Research Engineer

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

in cooperation with the
U.S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

The opinions, findings, and conclusions
in this report are not necessarily those of
the Department of Highways or the Bureau of
Public Roads.

September 1968

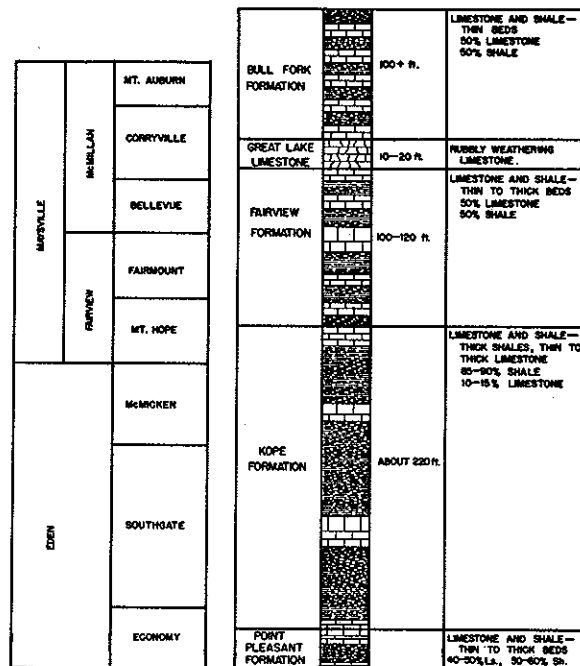


Figure 1. Generalized Columnar Section for the Covington, I 75 Slide Area.

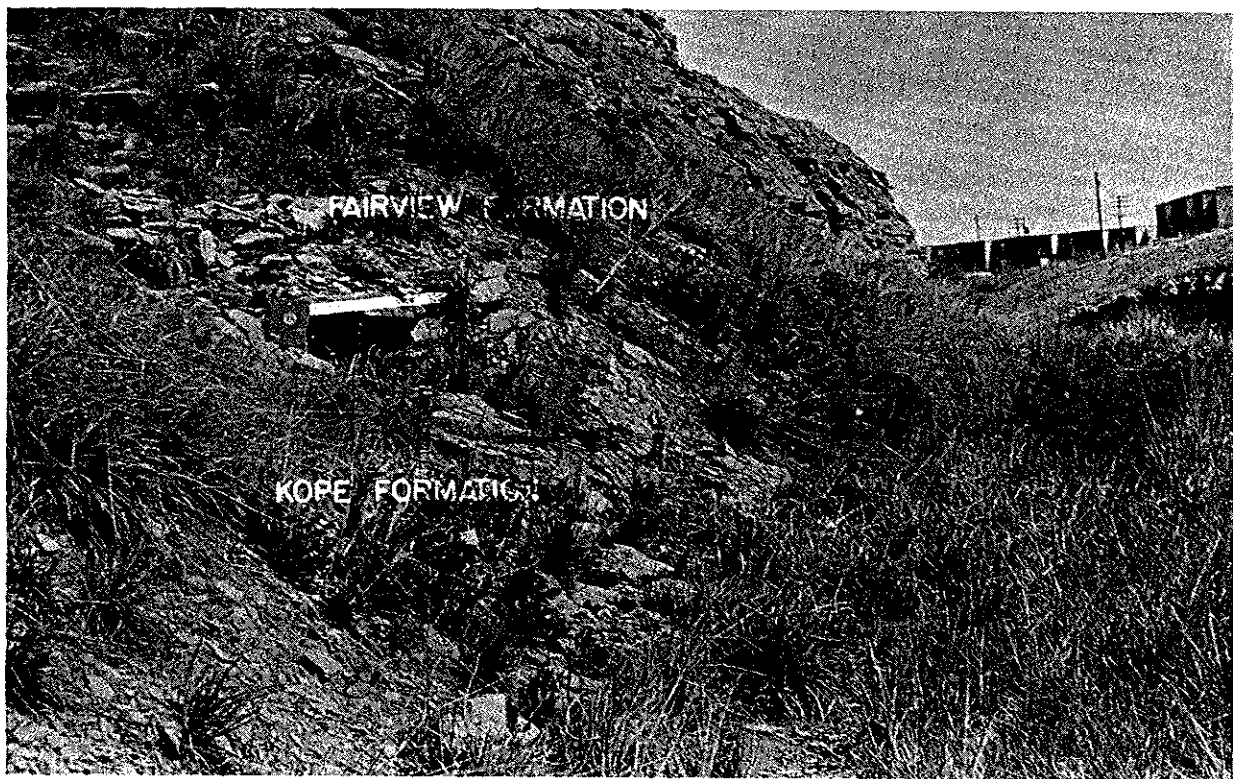


Figure 2. Fairview and Kope Formations at the Covington, I 75 Slide Area.

similar shales and, in one area, through an organic layer composed of old limbs, roots, and tree trunks. Longtime residents remember a sawmill that had been located in this vicinity.

Dickman Lake (see Figures 3 and 4) had been created by damming the depression created by an old quarry. Subsequently, sediments formed in the lake bed that varied from 10 to 35 feet thick above the limestone and shale deposits. Quite naturally, these unconsolidated sediments contained a great amount of water. It was estimated that this water would require five years to drain at the rate of 50 gph.

The prime source of offending water was thought to be Dickman Lake, located uphill and to the west of the slide area. A second source was the water outcropping on the west face of the rock cut between Dickman Lake and the slide area. Water from a third source could have been coming from the ravine to the west of the slide area.

HISTORY OF LANDSLIDE AREA

During the week of April 9, 1962, a significant amount of earth movement occurred near Station 487 and was sufficient to cause major damage to the essentially completed construction project. The site was visited by Division of Research personnel on April 16, 1962, and conditions were noted as shown in Figure 3. Figure 5, taken April 16, 1962, shows the extent of shoulder settlement. It was noted that the DGA base no longer supported the pavement, and the guardrail posts were out of alignment. There was a heavy clay embankment slope up to the shoulder pavement, thus preventing water from draining out of the DGA base.

The area of movement extended over a length of approximately 450 feet from Station 486+50 to 491+00. The toe of the slumped mass had moved out and over the embankment approximately two feet and was approximately one foot high.

A second slide of less severe nature had started to develop near Station 482. The shoulder had moved slightly down and away from the concrete pavement. The slope of the embankment in this area had been badly eroded by discharge from a 4-foot by 4-foot box culvert which passes beneath I 75.

During the summer of 1962 certain measures were undertaken to repair the damage and to prevent further movement. The measures are indicated by solid red lines in Figure 3 and are listed below:

1. In the major slide area, the embankment was removed to a depth of about 25 feet below the pavement. This zone was backfilled, recompacted, brought up to grade, and a new base and concrete pavement were constructed.
2. A perforated pipe was installed transversely at Station 487+05, about 12 feet below the pavement. The pipe extended to the median strip and was backfilled with sand.

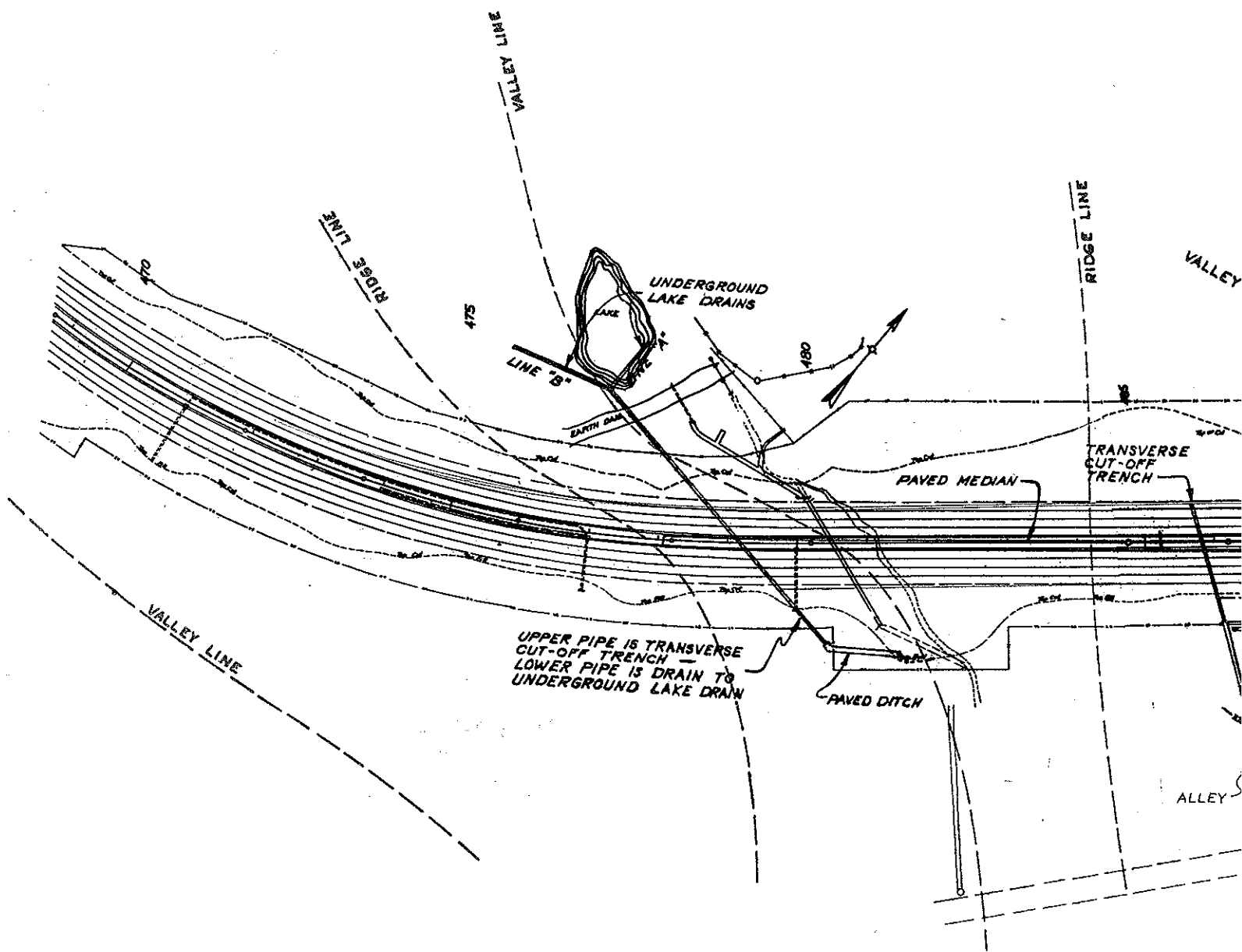


Figure 3. Plot Plan of Landsl

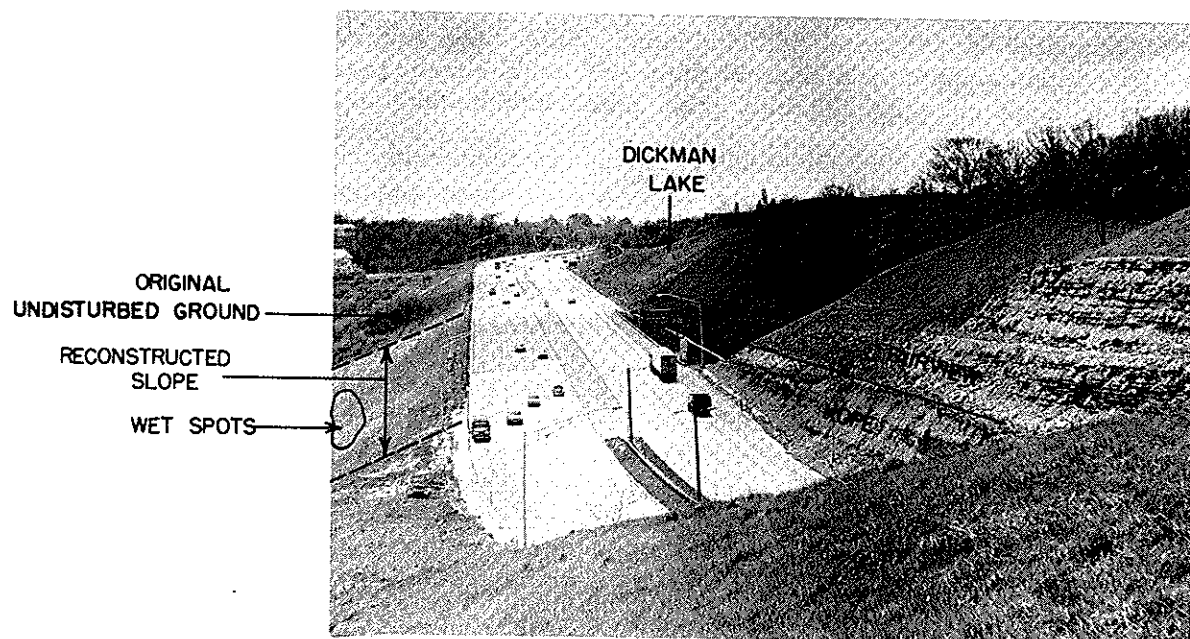


Figure 4. Overall View (Looking South) of Slide Area.



Figure 5. Area of Major Distress (Looking South), April 16, 1962.

3. In the west ditch line between Stations 472+50 and 489+00, a perforated pipe was placed at a depth of about 15 to 20 feet. The trench was completely backfilled with sand and then covered with a paved ditch.
4. On the east side of the pavement, a concrete shoulder with curb and gutter was placed between Stations 480+08 and 494+15.
5. A paved ditch was constructed in the east ditch line from Station 492+15 to Station 495+00.
6. The badly eroded ditch on the embankment slope right of Station 482 was paved.
7. Large areas where the pavement had been deformed, but not sufficiently to require replacement, were grouted. Some mud-jacking was also done in an effort to bring the slab back to the proper cross section.

Most of the above work was done by the contractor under an agreement for supplemental construction. The mudjacking was done by Maintenance personnel of the Department of Highways.

Slight movement of the embankment in the same areas that had slumped and in which repairs were made during the spring and summer of 1962 were again observed by District 6 personnel and reported to the Division of Research during the week of March 11, 1963. Conditions generally deteriorated during that and the next week. During the period March 25-28, 1963, Division of Research personnel visited the site and observed that there were indications of deep-seated movement in the parent, undisturbed material in the toe areas as evidenced by the distorted fence and telephone poles between Stations 486+50 and 489+75. The shoulder had settled and water seepage was seen on the slope of the fill and on the original ground at the toe.

From Stations 467+00 to 507+00 there were intermittent areas where considerable water was seeping from the joint between the outside driving lane and the shoulder in the southbound lanes. Water seepage was noted to be coming into the west ditch line, from the perforated pipe in the west ditch line, and from the transverse perforated pipe installed in 1962 at Station 487+05. The box culvert at Station 480+50 was sufficiently cracked to permit a large amount of water to escape into the fill.

A group of 44 timber piles varying from 25 to 32 feet long were driven vertically in March 1963 just outside the east shoulder between Stations 487+50 and 489+75 in a futile attempt to restrain movement of the fill. The zone between the piles and the shoulder was backfilled with clay. In addition, maintenance forces constructed a timber crib wall to contain the dense graded aggregate base under the pavement. The cracks in the box culvert were repaired.

The embankment continued to slide, causing the timber piles to bend and in some cases to move vertically with the unstable material, as shown by Figure 6. Telephone poles and the fence lines showed massive toe movement

(Figures 7 and 8) and by May 10, 1963, the embankment had started to move over the junction box to the 4-foot by 4-foot box culvert at Station 489+50 (Figure 9). By May 22, 1963, the main escarpment had dropped over eight feet, as shown in Figure 10. The slope of the embankment was dressed to reduce water infiltration, and the rate of movement decreased. However, Figure 11 shows that by July 11, 1963, a well developed crack had reappeared in the slope, suggesting continuing movement.

SUBSURFACE EXPLORATIONS

Evaluation of Early Exploration Data

In late April and early May 1962, and again in late March and April 1963, several holes were drilled in the median and along the shoulders. Large quantities of water were used to remove the drill cuttings. This, of course, made identification and assignment of depths very difficult. Soil profiles based on this information were prepared and presented in an interim report*.

The top eight to ten feet of the material in the median strip was a fine, silty sand which was highly permeable. Much of the precipitation which fell on the median would thus infiltrate into the soil. The logs of the drill holes and the profiles indicated the presence of an extremely wet and soft material at depths between Stations 477 and 482 (see Figure 3). The top of this soft layer ranged between five and ten feet, with the bottom 20 to 35 feet below the pavement. This zone appeared to exist only under the southbound lanes.

Near the west shoulder, it appeared that hard shale (probably undisturbed) was encountered a few feet below the pavement between Stations 483 and 487. At the centerline, this undisturbed material was again found between Stations 483 and 487 and at the east shoulder between Stations 483+50 and 486+50. This undisturbed material, and that fill material on the east slope between Stations 477 and 483, may have been acting as a dam and holding water in the basin beneath the southbound lanes between Stations 477 and 482.

There was a zone of wet clay at an elevation of 690 to 700 feet at Station 486+50. A similar material was found at Station 485+00 at an elevation of 700 to 710 feet. The profile in Figure 12 shows the continuation of this wet layer. A second, extremely wet layer was also noted at greater depths. This top, moist layer could represent a connection between the Dickman Lake basin and the landslide area -- which would permit the passage of water into the landslide area as the basin filled and overflowed. An additional drainage path between the basin and the slide zone may have been created in the summer of 1962 when a perforated pipe (backfilled with sand) was placed at a depth of 15 to 20 feet in the west ditch line.

The pavement was cored late in March 1963 at several locations in the outside driving lane of the northbound lanes between Stations 485 and 490.

*Deen, R.C. "Status Report on Landslide Area on I-75, Covington, Kentucky," Division of Research, Kentucky Department of Highways, May 1963.



Figure 6. Main Scarp of Landslide Showing Pavement Slab Settlement, May 22, 1963 (Looking North).

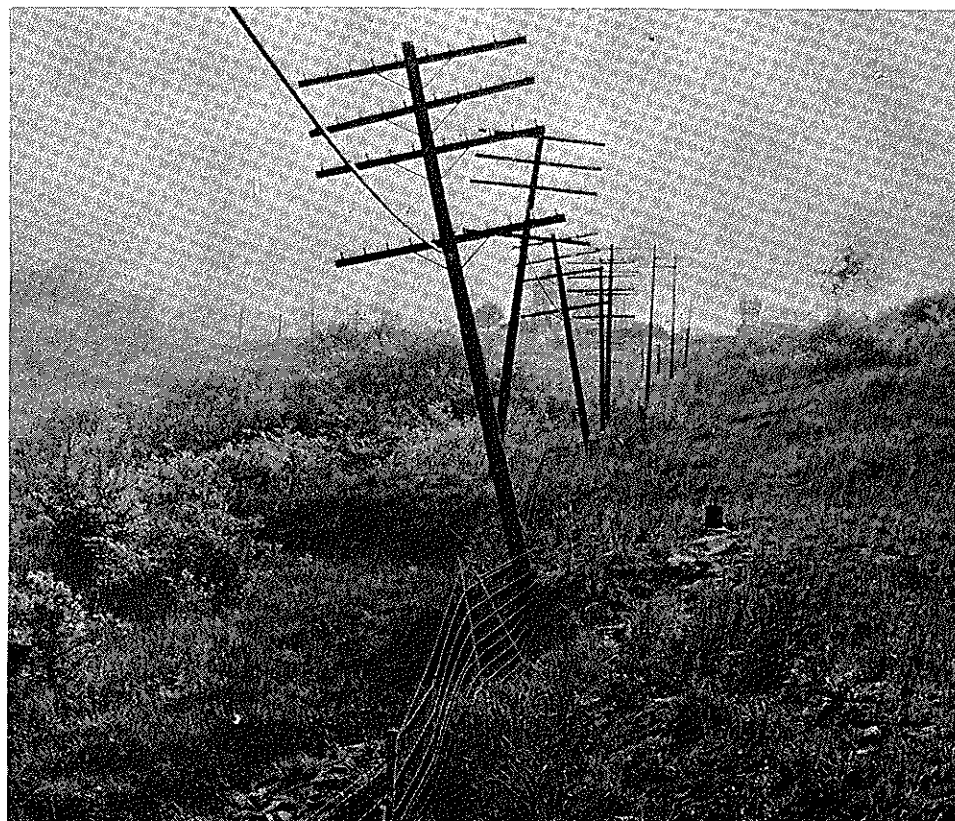


Figure 7. Condition Near Toe of Embankment, May 10, 1963 (Looking South).

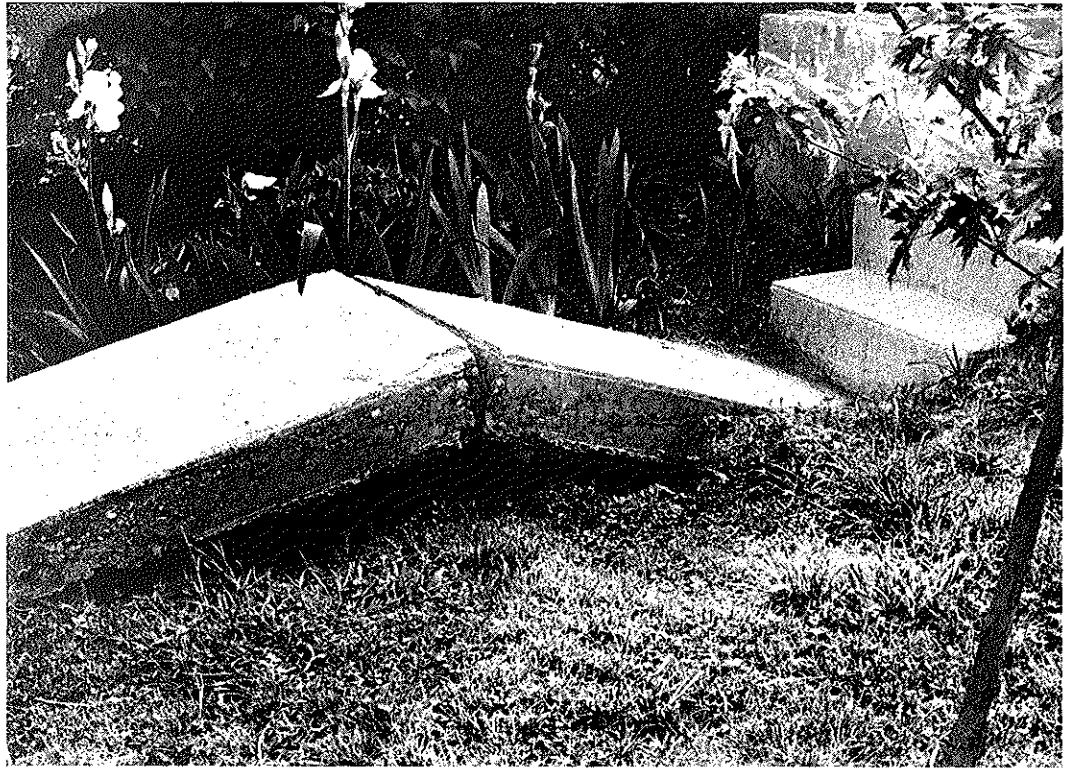


Figure 8. Buckled Sidewalk, Near Residence at Foot of Slope, May 10, 1963.

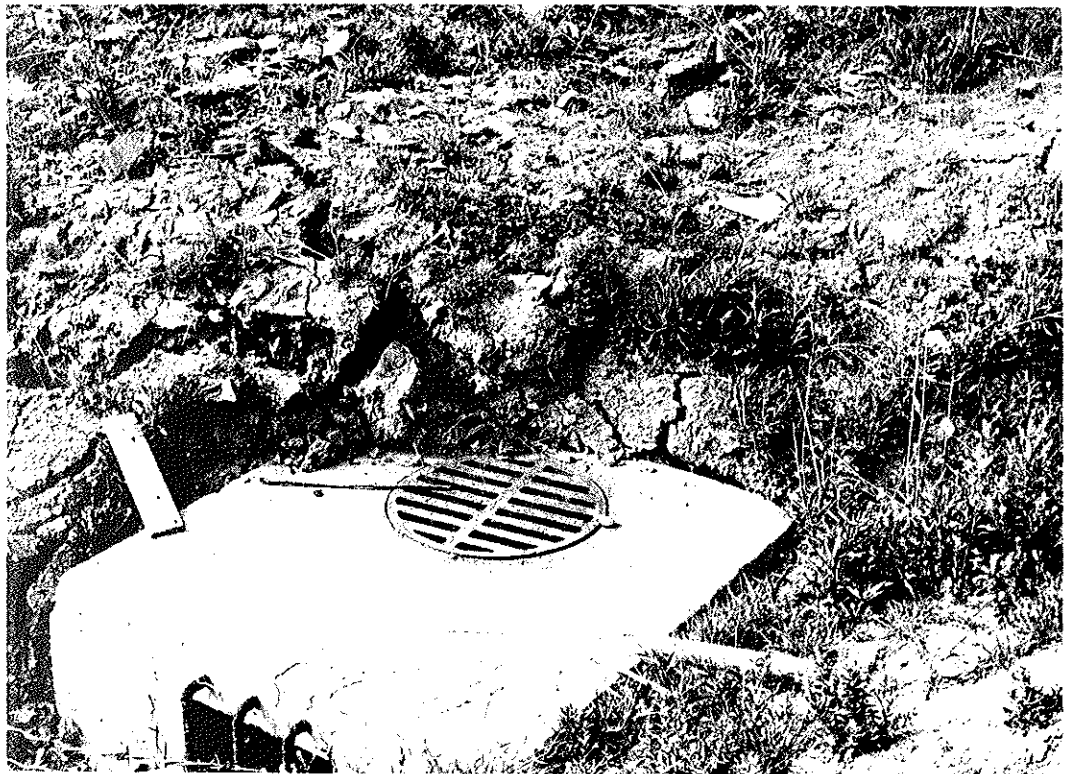


Figure 9. Soil Flow Over Junction Box, May 10, 1963.

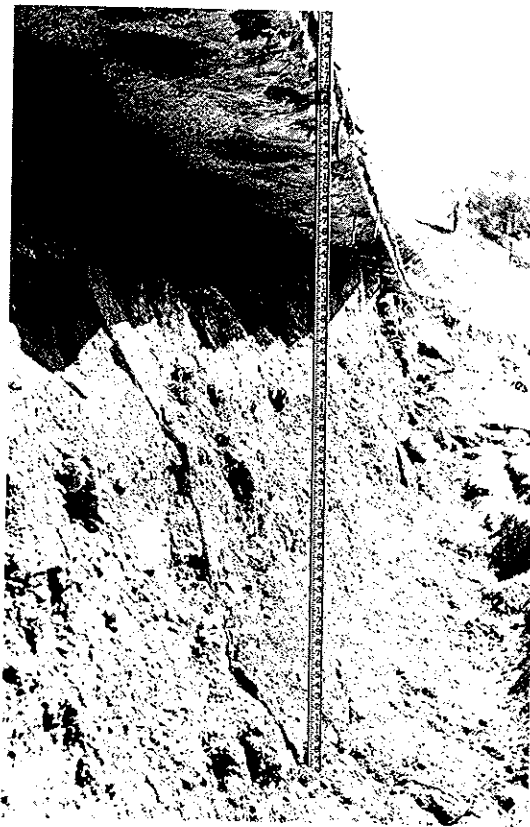


Figure 10. Main Scarp of Landslide, May 14, 1963.

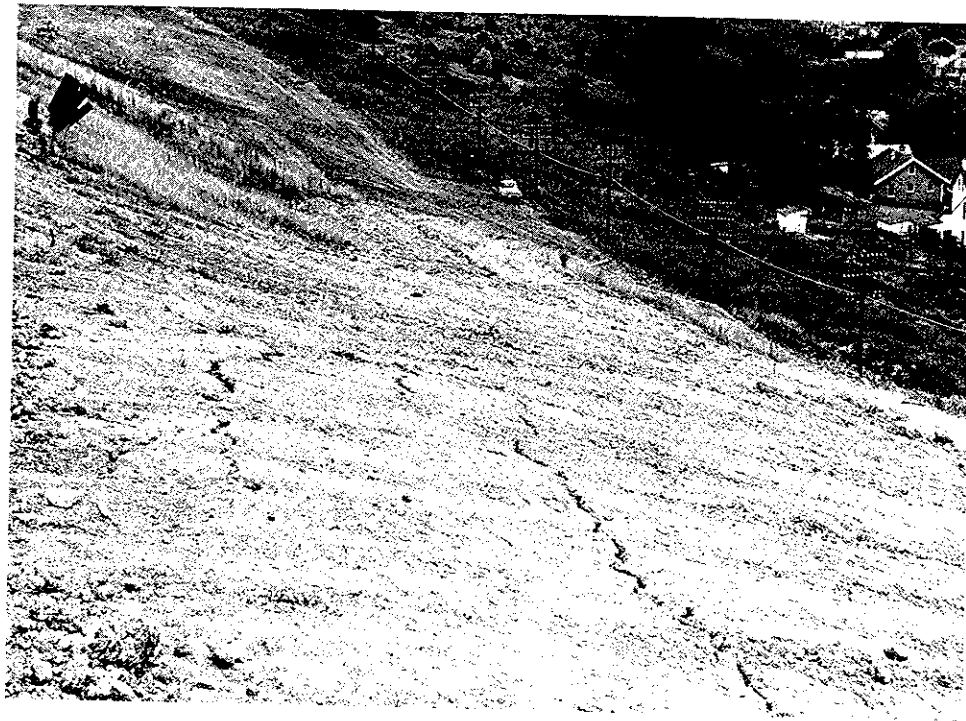


Figure 11. Condition of Slope, July 11, 1963 (Looking North).

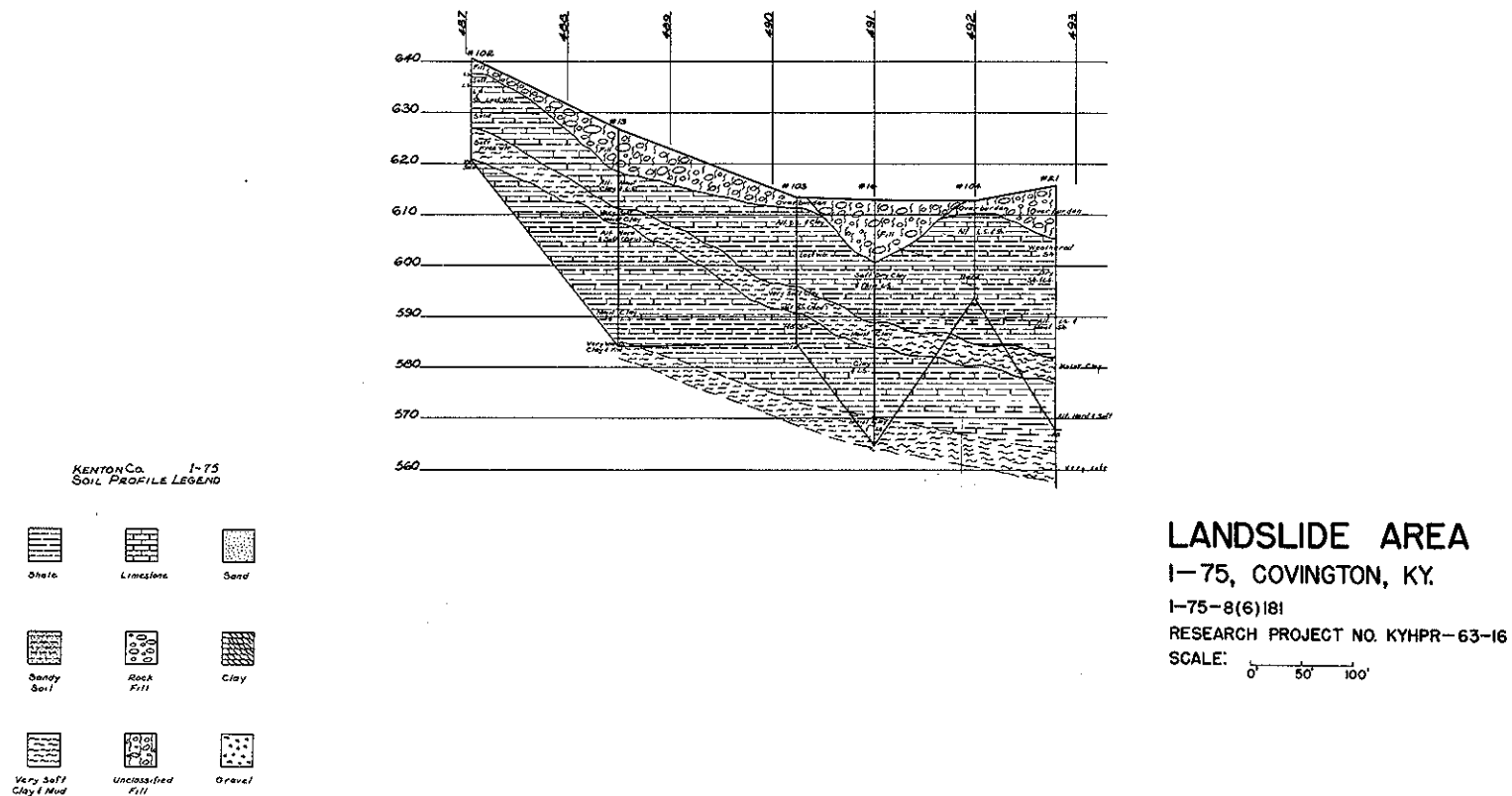


Figure 12. Soil Profile, Line C (222 Feet Right of Centerline)
(Taken from Logs of Auger Holes, 1963).

The holes were cored dry and reached to depths of approximately 18 inches -- just into the subgrade. The dense graded aggregate and subgrade soil removed from these holes appeared to be wet; and the next day after coring, free water was found to be standing within six to 12 inches of the top of the slab. Many of the drill holes in the median strip were also noted to have free water standing in them at depths of two to nine feet below the surface on the day after drilling.

Research Explorations

Additional subsurface data were obtained during June and July 1963 by vertical augering methods; and, since no water was used during the augering, identification of the soil material and depths to water-bearing layers was much more definite. Sufficient data were obtained to plot five soil profiles.* Figure 12 has been included to illustrate the general subsurface conditions. The profiles indicate that two extremely wet, soft layers of clay were detected. These layers appeared to be rather extensive in the vicinity of the slide. Both layers dipped to the east on about a 10 percent grade, and there may have been a direct connection between these layers and the lower portion of the deep mucky clay in the bottom of the lake (Dickman) which lies to the west of the highway at Station 478.

Near Station 490, and 222 feet right of the centerline (see Figure 12), a 4-foot by 4-foot box culvert was located at an elevation of approximately 585 feet, just below the upper water-bearing layer. Visual inspection indicated that the culvert had sustained no structural damage, and it was concluded, therefore, that the culvert was located in stable material. The upper wet layer in Figure 12 was thought to be very weak and to be the zone in which movement and slippage was occurring.

The water in the two wet layers was under considerable head. At the time the auger penetrated these layers, the water rose very quickly to as much as 20 feet above the elevation of the water-bearing layer. It should also be noted that the water contained in these layers had a very pronounced odor and felt greasy to the touch. This same type of water was encountered in the mucky clay in the bottom of the Dickman Lake.

A water-bearing layer at a higher elevation was noted at 145 feet right of the centerline between Stations 488+50 and 491+00. This layer was approximately ten feet below the surface of the slope and could have been the weak material in which slippage had occurred in a secondary slide within the major distressed area. It should also be noted that the water in this perched layer was different, being clear and clean, from that observed in the lower water-bearing layers.

*Deen, R.C. "Status Report on Landslide Area on I-75, Covington, Kentucky," Division of Research, Kentucky Department of Highways, August 1963.

CORRECTIVE MEASURES

Several measures were considered as ways to improve the stability of the moving soil mass. It was felt that excessive seepage water in certain zones of the slide-prone area was the significant factor causing the instability. The key to correcting the landslide thus involved adequate control or cutoff of the several sources of water which were thought to exist.

Plans and specifications were prepared and a contract to correct the slide was awarded in the fall of 1964. The plan to correct the slide consisted of measures to control the sources of seepage and provided for approximately 1600 linear feet of cutoff or interceptor trenches five feet wide and averaging about 30 feet deep, with 10-inch perforated pipe and sand backfill. Some 1150 feet of the trenches were positioned so that they would intercept seepage water above the slide and carry it away from the area. The remaining 450 feet was to be placed parallel to the centerline of the roadway near the toe of the unstable mass.

The plans and specifications provided for the following corrective measures (see Figure 3):

1. Drain and fill Dickman Lake. Drainage was to be effected by the construction of interceptor trenches near the east bank of the lake. The fill was to be constructed of clay material approved by the Engineer and was to include a channel change and seeding.
2. Construct trenches transversely across the highway at Stations 479+55 and 486+33 to intercept water which may be moving beneath the roadway toward the landslide from the high ground to the south. The first trench was located just uphill (south) from a minor slump area, and the second trench was just above (south) the main landslide.
3. Construct a drainage cutoff trench left of Station 489+50 and parallel to the centerline to intercept water which might come from the original ground west of the highway.
4. Construct an interceptor drainage trench located 230 feet right of and parallel to the centerline near the toe of the main slide. Three lateral drainage pipes to carry off seepage were to be connected to the 12-inch pipe installed in the trench.
5. Excavate the top 30 feet of the original slope in the main slide area and backfill on a 2:1 slope with a lightweight material.
6. Construct 450 feet of fill on a 4:1 slope starting 30 feet below the pavement and extending downward toward Highland Avenue near the base of the fill.

7. Remove damaged pavement and replace with temporary pavement (bituminous concrete).
8. Pave 800 feet of the median.
9. Construct paved ditches as required and seed all newly constructed slopes.

Reconstruction of the distressed area was done under contract numbers FI 75-8(21)187 and SP 59-315-30.

It was hoped that the above construction would be sufficient to stabilize the distressed area. However, a second phase was programmed to provide for the construction of a rock buttress (see Figure 13) near the toe of the embankment. By keying this lug into dry, firm bedrock, additional lateral resistance to movement would be available. The second phase also provided for the replacement of temporary pavement by portland cement concrete pavement after consolidation had ceased and the area was stabilized.

CONSTRUCTION WORK

Dickman Lake

The surface water in the lake was drained by installation of a surface drain through the dam, and approved fill material was hauled in and placed. The subsurface materials were so unstable that the new fill material sank and the mucky subsurface materials came to the surface. After considerable work, the area was essentially stabilized by blending the muck and the new fill materials; however, wooden rafts were required as a working platform for the cranes.

After stabilization of the lake bed surface, the two cutoff drainage ditches were installed. This was accomplished by driving sheet piling on both sides of the trench line to depths varying from ten feet at the lake edge to 42 feet at the intersection of the trenches near the dam. In most places the sheet piles extended at least five feet into shale seams and (or) were driven to refusal. Material between the two rows of piling was removed by a clamshell bucket (see Figure 14). Sump pumps were used continually to remove water that seeped through the piling. Ten-inch perforated pipe was laid in the bottom and sand backfill was placed to within five feet of the lake surface. Clay fill was used for the remaining five feet. Upon completion of the two cutoff trenches, the piling on the upstream side was removed. The piling on the downstream face was left in place to provide a more positive seal or cutoff of seepage water.

A trench was dug between the lake dam and the south cutoff trench across the interstate. A 14-inch hole was augered under the dam to the point of intersection of the lake drains. A 10-inch pipe was pushed through the hole (Figure 15) and connected to the bottom pipe of the cutoff trenches. Sand backfill was placed in the trench and the piles on the south side were removed.

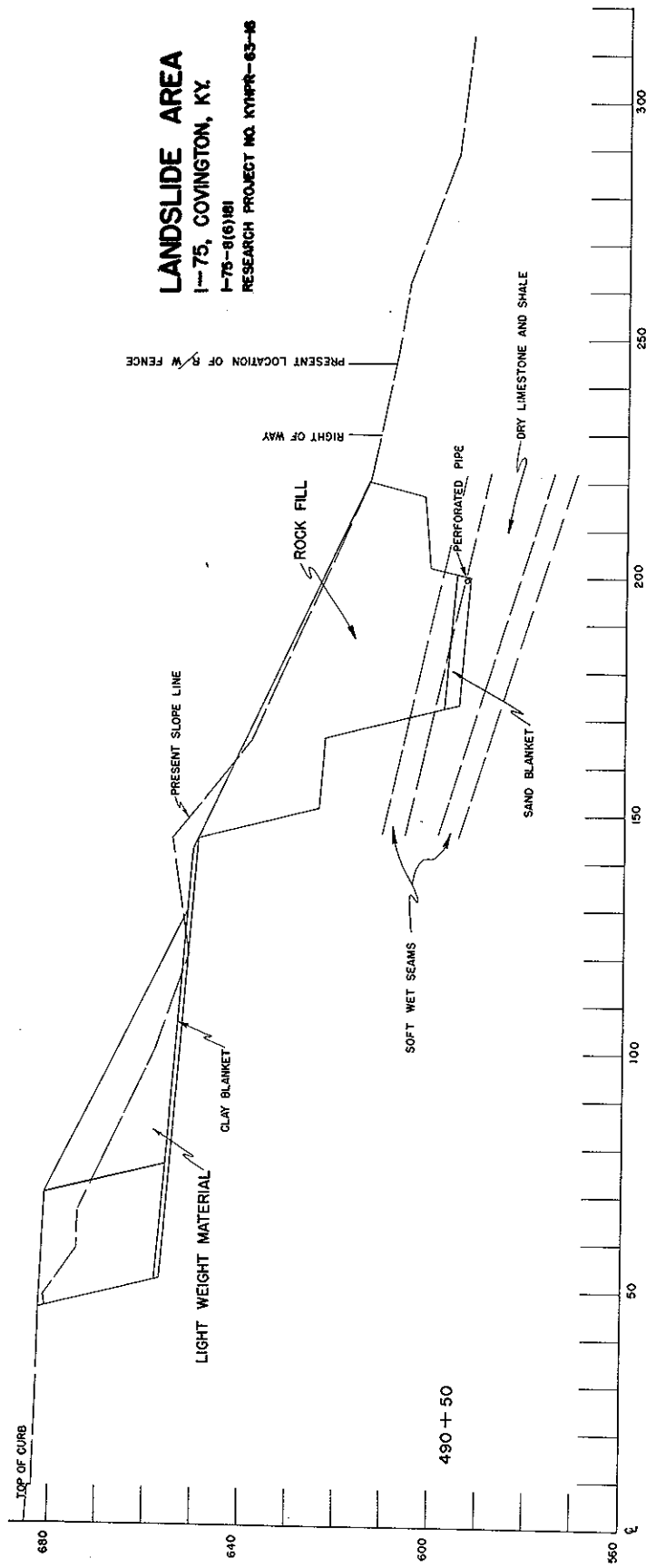


Figure 13. Typical Section Showing Planned Repairs of Landslide Area.

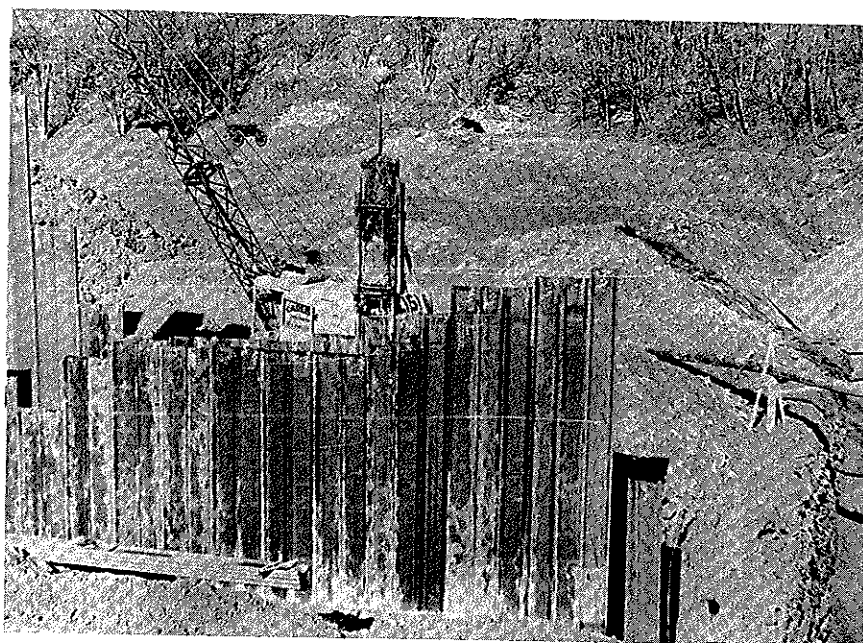


Figure 14. Construction of Cutoff Trenches in Dickman Lake.



Figure 15. Ten-Inch Effluent Pipe From Dickman Lake Cutoff Drains.

Cutoff Trenches Across the Interstate

Two cutoff trenches were installed across the interstate; the south trench was at Station 479+55, the north one at Station 486+33. Both trenches were installed by driving two rows of sheet piling, excavating from between the sheet piles, placing 10-inch perforated pipes at two different elevations in each trench, and backfilling with sand. The piling on the upstream, or uphill, side of each trench was then removed. The pipes in the south trench were installed 10 to 19 feet below the pavement surface, and in the north trench they were 11 and 21 feet (Figure 16) below the pavement.

Cutoff Trench Left of Station 489+50

An interceptor trench parallel to the centerline and left of Station 489+50 was constructed as described above. This trench was constructed to intercept a possible ground water source to the left (west) of the major slide area. To provide a drainage outlet, a tunnel was constructed from the low point in this trench to the existing 4-foot by 4-foot box culvert, and a tunnel liner and a 10-inch pipe were installed in the tunnel.

Cutoff Trench Near the Toe of the Old Fill

This trench, located 230 feet right (east) of and parallel to the centerline, extended from Station 487+00 to Station 491+50. Three laterals extended to the right of the trench and were located at Stations 488+50, 489+50, and 490+50. Perforated pipe (12-inch diameter) was laid in the bottom of the trench and backfilled with sand. Seepage was a major problem in the construction of this trench. Trench walls collapsed or closed in width in a number of locations, sometimes more than once in the same location. Major and minor slip planes (Figure 17) were found in the original fill and in the parent material during the construction of this trench. Concurrently, in the area of the 4-foot by 4-foot box culvert (Figure 18), the water flow became greater, and the source was attributed to a break in the box culvert. This will be discussed in more detail in the next section.

The only lateral drain that has had any water flow to date is the one at Station 490+50 (Figure 19). Water is still flowing out of this lateral at a variable rate but generally averages less than one gallon per hour.

Repair of 4-foot by 4-foot Box Culvert

During construction of the cutoff trench described in the previous section, considerable water was encountered in the area of the box culvert. Upon inspection of the interior of the culvert, it was found to be broken in the 4-foot length containing the old manhole at the toe of the original fill. This section, as well as the transition section and the first two lengths of a 42-inch round concrete pipe on the exit side, were found to have broken joints (Figure 20), and the sections were telescoped one inside another. In the large break above the manhole section, the major slip plane could be seen directly on the top of the box culvert. This also corresponded

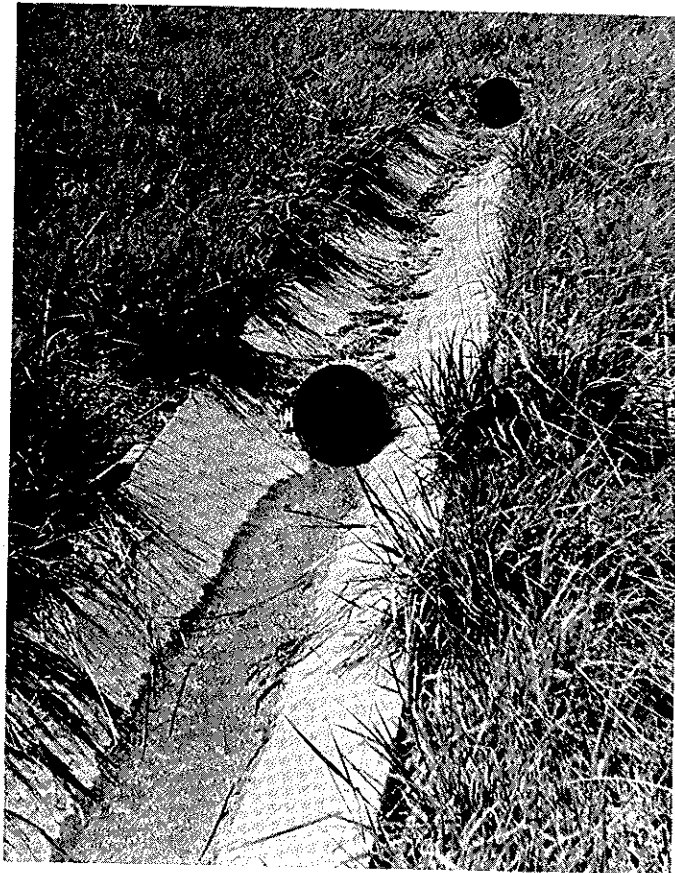


Figure 16. North Transverse Cutoff Trench Drain Pipes, May 1968.

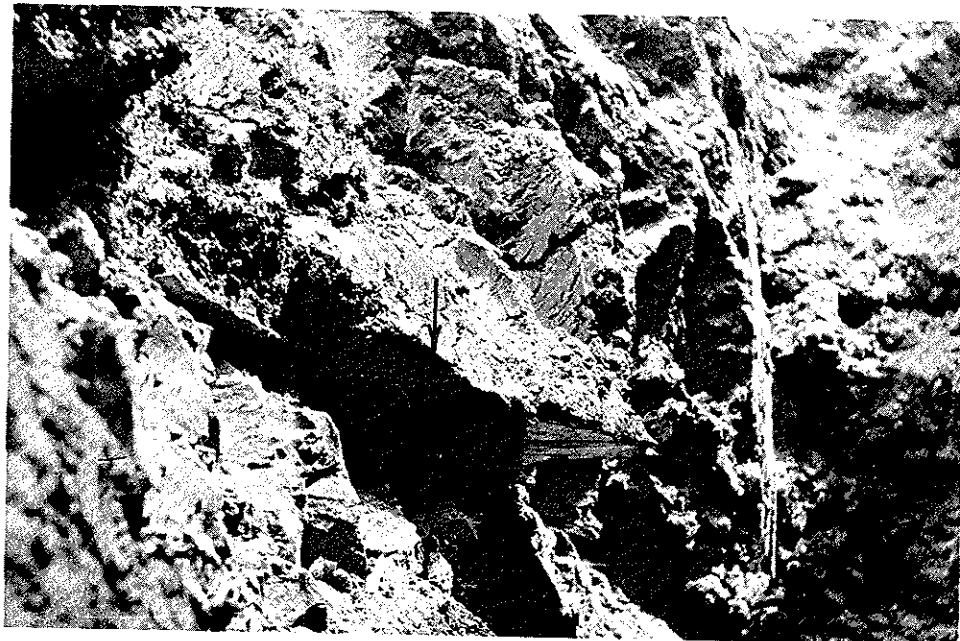


Figure 17. Major Slip Plane in the Trench at the Toe of the Original Embankment.



Figure 18. Trench Drain Pipe Under 4-Foot by 4-Foot Box Culvert,

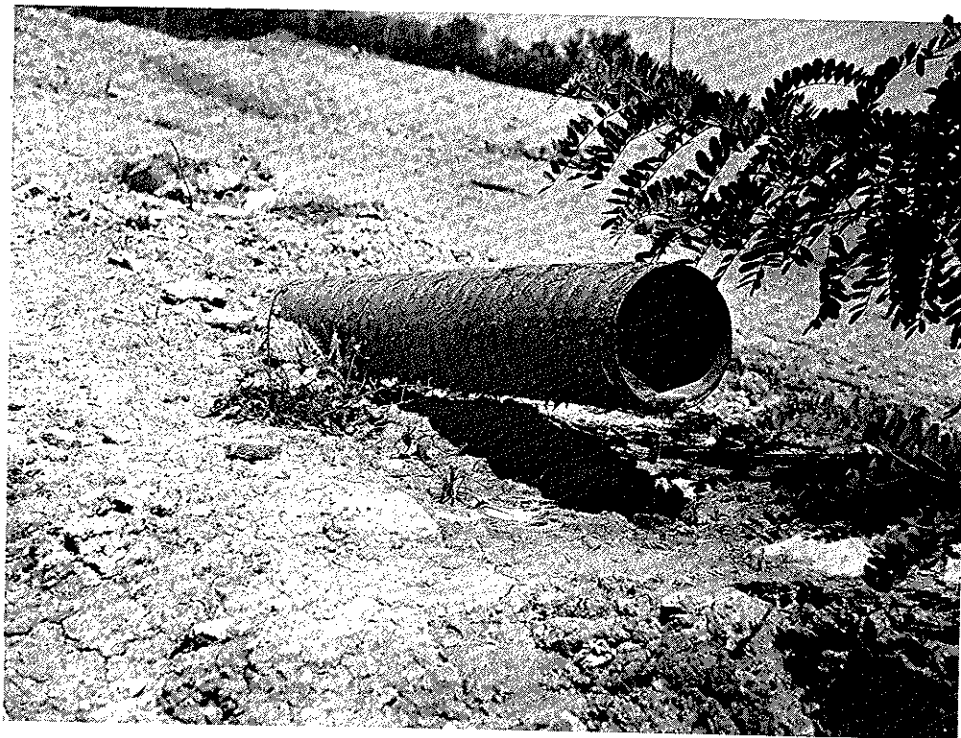


Figure 19. North Lateral Drain Pipe.

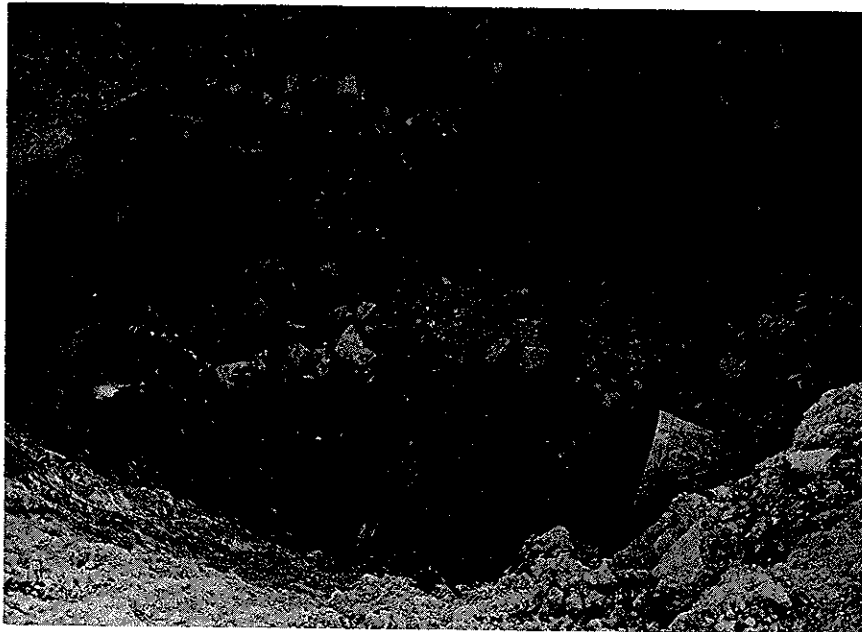


Figure 20. Broken 4-Foot by 4-Foot Box Culvert.

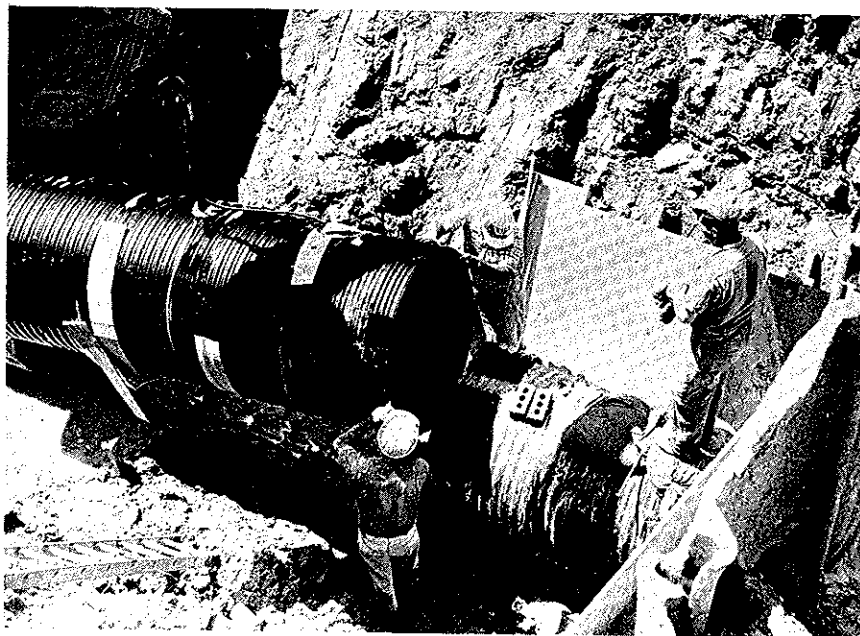


Figure 21. Corrugated Pipe Replacement for Broken Box Culvert.

with the elevation of the major slip plane observed in other portions of the cutoff trench. Sheet piles were driven above the damaged culvert and the fill excavated. The damaged sections were removed, and an 18-foot length of bituminous coated steel pipe was installed to join the undamaged ends (Figure 21). The hole was backfilled with clay material, except where the toe cutoff trench crosses the area; sand was used as the backfill material in this zone.

Reconstruction of the Embankment

Reconstruction plans called for the removal of the top 30 feet of the fill and the construction of a 4:1 slope starting at an elevation of 30 feet below the pavement and extending downward towards Highland Avenue. During the construction of the cutoff trench parallel to the toe of the embankment, additional movement of the fill could not be restrained. Cracks developed that ranged from a fraction of an inch to 18 inches wide and as much as 54 inches deep. The north and south ends of the fill became riddled with cracks from top to bottom; however, the center portion remained stable. A change order was issued to provide for additional drainage at the north and south ends of the original slide area. In order to place these pipe, benches were excavated -- the south bench extended from Station 486+00 to 489+50 and averaged approximately 75 feet in width (Figure 22) and the north bench extended from Station 490+50 to Station 493+00 and also averaged about 75 feet in width (Figure 23).

The material removed from the benches was used to construct the 4:1 fill. The south bench was brought to grade first, and the excavated material from the north bench was used to partially backfill the south bench. Considerable slippage of fill material from above the benches was noted during this operation (Figure 24).

The general cross section of both benches was such that water would drain from the top edge of the 4:1 slope towards the road (Figure 23). This necessitated the installation of a 10-inch perforated pipe, with perforations down, at the intersection of the vertical face and the bench floor. Sand backfill was placed in sufficient quantity to cover the pipe. An elbow was installed at the low end and a 10-inch perforated carry-off pipe, with perforations up, was connected to the elbow. The carry-off pipe was installed so that five feet extended beyond the surface of the 4:1 slope. The free ends were positioned near the raised manhole (Figure 25).

The embankment area was brought on a 4:1 slope to a grade line 30 feet below the pavement. At this point the slope was changed to 2:1, and a lightweight slag was used as fill (see Figure 26). The slag fill extended under the outside 12-foot driving lane and 12 feet to the right of the curb line. A two-foot thick clay blanket was placed over the horizontal slag surface, and an 18-inch thick lift was placed over the side slope of the slag. All newly constructed slopes were seeded.

Pavement Construction

Areas of pavement, damaged by the slide or by reconstruction, were



Figure 22. South Bench Construction.

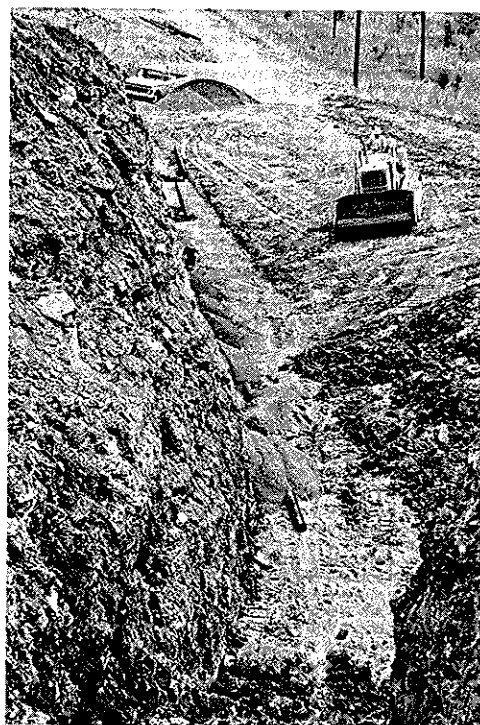


Figure 23. North Bench Construction and North Bench Drain with Sand Backfill.

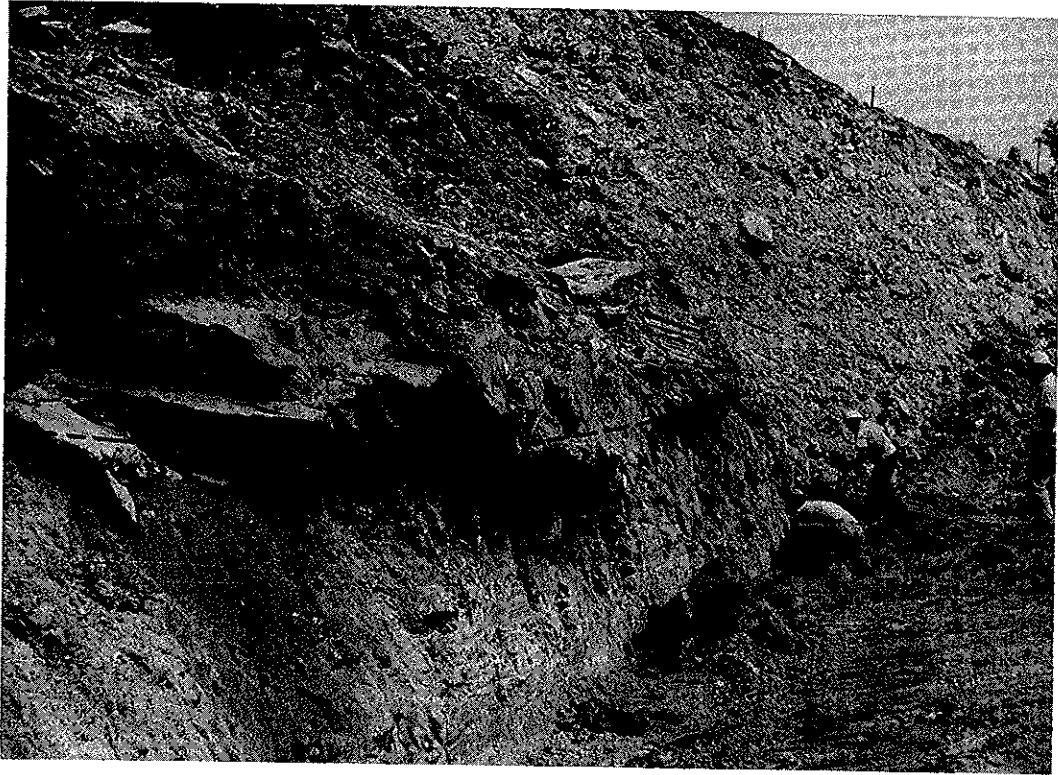


Figure 24. Slip Plane in South Bench.

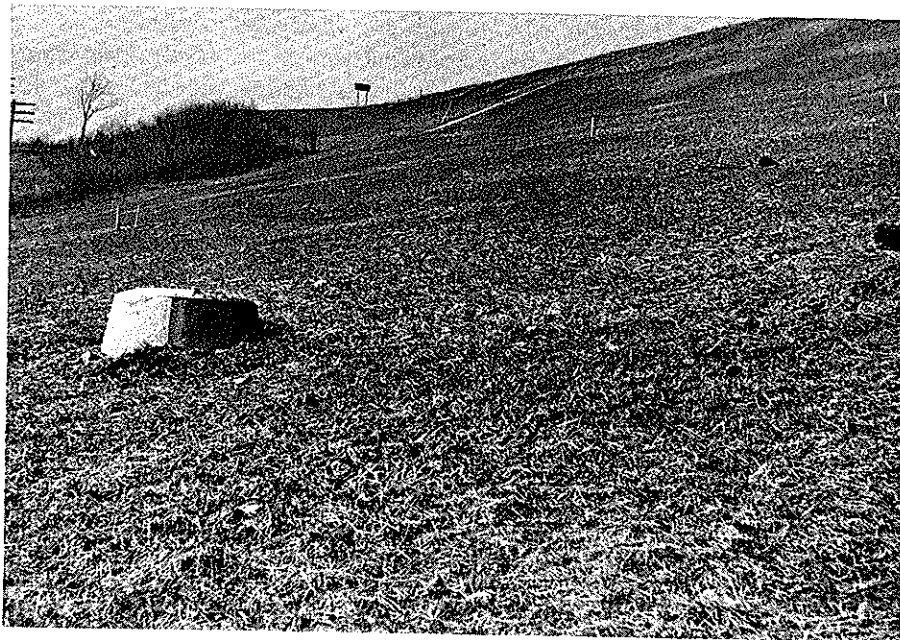


Figure 25. North and South Bench Drains and Raised Manhole.

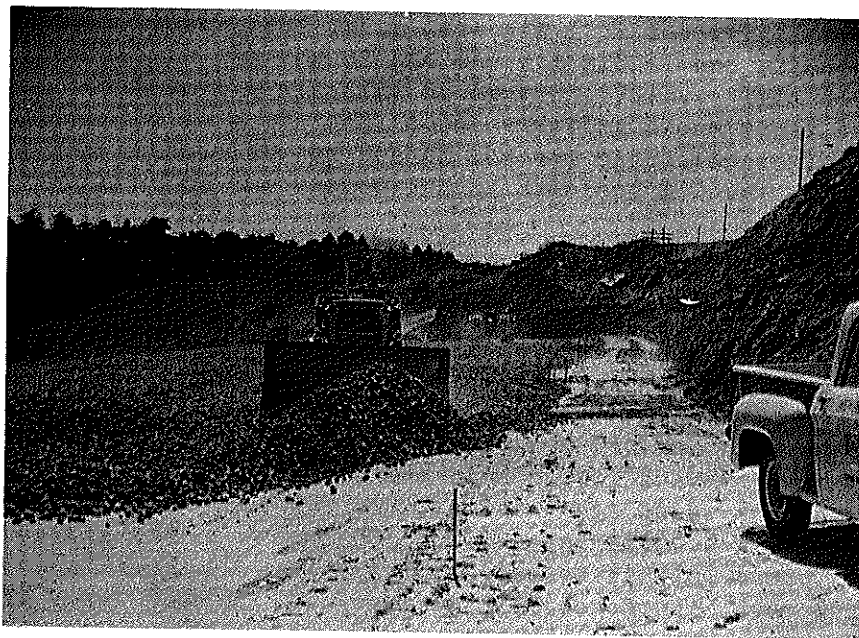


Figure 26. Lightweight Slag Fill.

removed and reconstructed. The old dense graded aggregate was removed, new base was placed and compacted, and an asphaltic concrete pavement was constructed. Flexible pavement was used as a replacement so that repairs could be made easily as the fill and foundation materials consolidated, causing settlement and distortion of the riding surface.

Median Repairs

The top 12 to 15 inches of the soil in the median was removed, dense graded aggregate laid and compacted and a four-inch layer of asphaltic concrete placed between the curbs. Two auger holes that had been drilled and lined with gutter pipe near the south cutoff trench were left open for future water level observations.

Guardrails and Ditches

Guardrails were removed and replaced as found necessary within the construction area. Paved ditches were constructed as follows:

1. A ditch was constructed to collect and direct the flow of water from both pipes in the south cutoff trench to the existing paved ditch.
2. A paved ditch system was constructed in the area of the cutoff trench to the left of the major slide area.
3. A circumferential paved ditch was constructed around the toe of the new 4:1 slope that connected the two pipes in the north cutoff trench, the three laterals from the cutoff trench parallel to the toe of the old 2:1 slope, and extended on north to the vicinity of Station 495+50. This ditch was connected to a 42-inch round, existing storm sewer by constructing a new manhole at the toe of the 4:1 slope, approximately 60 feet west of the centerline of Highland Avenue.

POST-CONSTRUCTION CONDITIONS AND PERFORMANCE

Surveillance of Drainage Conditions During and Since Construction

Water flow from the underground drain from Dickman Lake was conservatively estimated at 300 gallons per hour at the time of the initial connection. Water continued to flow at this rate for approximately six weeks and has gradually diminished since the end of July 1965; the present rate of flow is approximately 30 to 40 gallons per hour. Water has never ceased flowing since the line was completed. The upper pipe of the south cutoff trench has never drained water.

The augered vertical observation hole in the median to the south (uphill) of the trench line is now dry. The other hole to the north (downhill) of the trench line still contains water; however, it cannot be determined if this is due to underground drainage conditions or surface drainage. The surface of

Dickman Lake has remained essentially dry and has been found wet only immediately after storms.

The north lateral connected to the cutoff trench parallel to the toe of the old 2:1 slope flowed between two and three gallons per hour upon installation. Water has never ceased to flow from this pipe; however, the flow is presently in terms of drops of water. The flow rate decreased sharply upon completion of repairs to the broken 42-inch concrete sewer pipe. The odor of raw sewage is pronounced in this pipe at the present time.

The south bench drain had a very small flow of water upon completion of construction. Water flow ceased a few weeks later and for the most part has been dry since then. It has, however, shown evidence of moisture drainage after a long wet-weather spring season.

Water drained out of the north bench drain pipe until the fall of 1965. However, the sand backfill around this pipe has never dried and has kept the area below the end of the pipe continually wet. Highway maintenance forces have connected the ends of the drain pipes from both benches to the raised manhole, however nothing has been done to intercept the water drainage from the surrounding sand.

A wet area in the original fill was observed on January 12, 1965. During construction of the north bench on August 11, 1965, a wet area was encountered 25 feet south and 10 feet west of the south end of the north bench. This was within 5 to 10 feet of the area located January 12, 1965. Water was seen standing in pools back in the embankment; however, this pocket was not disturbed during the bench and fill construction. This may account for the wet sand backfill around the north bench drain outlet.

Since completion of the fill, wet areas have been found on the surface of the slope in the same general area, about 35 feet below pavement grade. This area has been alternately wet and dry since October 1965, apparently depending upon weather and (or) underground water conditions. An attempt to auger and tap this water was made in January and February 1968 without success. It may be desirable to attempt again to locate the source of the water by horizontal augering under more control.

The smaller fill opposite the Dickman Lake dam has shown evidence of water seepage on the slope since February 23, 1966. This wet area was approximately 50 feet north of the old paved ditch and 4-foot by 4-foot box culvert and approximately 12 to 15 feet above the old paved ditch. This area remained wet until November 1967 when maintenance forces augered horizontally into the area. Five holes were augered for a length of 144 feet each in an arbitrary fan-shaped pattern. One hole hit a pocket of water on November 20, 1967. The 6-inch pipe flowed full for three hours, after which the flow decreased rather rapidly. By December 1, 1967, the flow had decreased to about a 1/2-inch diameter stream and then to droplets by March 1, 1968. Inspections between March 1, 1968 and May 9, 1968, have shown this area to be alternately wet or damp.

The alternately wet-dry areas on the slope of the embankment in the major slide zone would appear to be in the original natural drainage path from the valley left of Station 489+50. On April 26, 1968, an inspection of this valley revealed a large quantity of water flowing toward the drop inlet to the 4-foot by 4-foot box culvert located under the embankment (Figure 27). It was observed that the quantity of water reaching the box inlet was considerably less than that coming from the valley. The water flow coming from the valley was approximately 300 to 400 gph at a point 200 feet from the inlet, yet 55 feet from the box inlet, the ditch bottom was dry. Two areas were found in the ditch bottom where water was seen to disappear underground.

On April 29, 1968, the entire valley mentioned above was inspected for water sources. A 15-inch sanitary sewer line was found approximately 500 feet upstream of the box inlet. This pipe contained three breaks and raw sewage was profusely deposited over the area. On May 7, 1968, a 6-inch diameter stream of water was observed to be coming out of a hole in the embankment above this sewer line.

In addition to the above line, the sanitary sewer line located on top of the Dickman Lake dam was found to be badly broken at the south end of the dam. Raw sewage was flowing over the dam, down onto the lake bed and into the surface drainage ditch.

Pavement Conditions

The flexible pavement in the area of the major slide has shown some minor signs of consolidation. No cracks have been seen in this pavement.

The portland cement concrete pavement just north of the south cutoff trench across the highway has settled approximately five inches and moved horizontally outward approximately two inches. It is significant that approximately four inches of this settlement has occurred since December 1, 1967 -- after the water pocket was tapped by augering.

The remaining pavement appears to be in good condition -- that is, considering weather, traffic, anticipated consolidation of the fill and foundation, and generally expected signs of deterioration.

Reconstructed Embankment Conditions

The earth fill appears to be holding quite well as of the date of this report. Some minor erosional slips have been observed on the clay blanket slope over the lightweight slag fill. This was to be expected because of the relatively thin layer of soil on this slope.

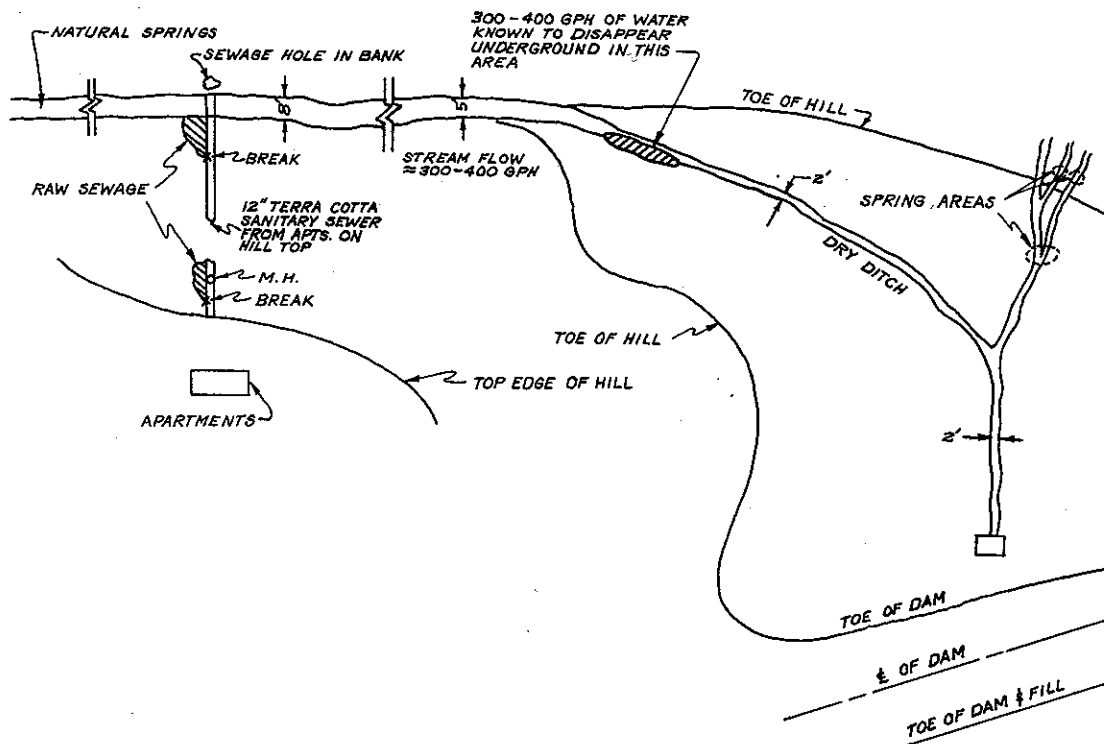


Figure 27. Sketch Showing Locations where Surface Water Was Observed to Disappear Underground.

CONCLUSIONS

Observations during construction and the performance since construction suggest that the corrective measures incorporated in the reconstruction of the slide area have been effective in stabilizing the moving earth mass. Performance surveys indicate that the fill and drainage construction features have generally been effective in their intended purposes. The drainage maintenance work done since construction has generally performed as desired.

This case history again suggests the importance of a proper and early consideration of geology, soils, and topography in selecting the route of highway facilities and in the design of such facilities. An early consideration of soils and geologic conditions of an area may often lead to better locations which would minimize the possible occurrence of landslides, or, if such locations are not available, various design features could be incorporated into the project to minimize the detrimental effect of the occurrence of landslides.